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LIFE IN THE SEA.

BY CHARLES MINOR BLACKFORD, JR., M. D.

SHOULD some observant savage be placed where, at one glance, he might take in the luxuriant growth of a tropical forest and the restless sweep of the ocean, it is likely that the contrast between the teeming life of the one and the apparent desolation of the other would produce a profound impression on his mind, and that he would wonder that each inch of earth, every ray of sunlight, should be fought for on land while the great expanse of the sea lies vacant and idle. He would watch the gaily decked birds flit from branch to branch, the iridescent gleams from serpents as they glide through leafy coverts, or the gorgeous coloring of butterflies that flash through the dense shade of the jungle, and he would doubtless deride the suggestion that the sullen waters could vie with earth either in numbers or in the tints and shades of its inhabitants. The dark waves seem a fitting abode only for strange, mis-shapen monsters.

Such was the opinion that prevailed for centuries; and it has been only in recent years that it has undergone a change. Startling as it may appear, it is none the less true that in regard to population the land deserves the reproach of barrenness rather than the sea, for the latter contains a flora and fauna of a richness that the land cannot rival. To suit peculiar conditions of environment, marine organisms, like their terrestrial relatives, undergo many modifications of shape and function, and cause the natural history of the sea to be as replete with interest, and to present as wide a range for study, as that of earth and air. At first glance, such would not seem to be the case, for the conditions of marine life are apparently extremely uniform; but closer study shows that the uniformity is superficial, and the most trifling ex-

amination reveals differences in genera, in species and in individuals that are bewildering in their numbers.

In the light of our present knowledge, it seems probable that life on our earth originated in the sea, when and how we know not. Weismann* states it succinctly when he says: "The sea is the birthplace of all animal and plant life; from it animals and plants have spread themselves on the land and into the fresh waters." The condition of the sea at the early period at which life appeared gives strength to this supposition. The vast body of tepid water rolled its sluggish waves under masses of cloud, and in the same water, rich with the washings of the land, life came into being. It was a very low grade of life, merely a mass of jelly-like protoplasm, but it possessed the power of producing young and of undergoing changes that fitted it for higher things than simple existence. In time, organisms came about that were better adapted to securing food than certain others, or that were stronger and so captured and devoured the weaker species. As the seas grew more crowded, the struggle for food became more and more bitter, till the feebler forms of life were in danger of extermination unless they could find a refuge. These asylums were ready, but the fugitives had to undergo some changes before the promised safety was attainable. They probably advanced into the fresh water by slow degrees, each generation being forced further from the ocean by the struggle for food; but being freed from many natural enemies, the increase in numbers went on rapidly, until the weaker again became the prey of the stronger, and the bitter fight for existence became as keen as before. The scale, however, is smaller, and the rivers are still safer than the open sea for many organisms. For this reason, the shad, salmon and some other sea fish seek the upper reaches of the streams as a spawning ground, so that their young may attain a fair degree of maturity before being exposed to the numberless dangers that beset them in the ocean. The young fry have difficulties to overcome that suffice to eliminate the weaklings and teach the survivors to care for themselves; but it is more than likely that, in the migration of the spawning fish, we have but the repetition of the flight that populated our streams.

Another retreat was the bottom of the sea, and this was sought

* "*Das Thierleben im Bodensee.*" S. 5, Lindau, Stettner, 1877.

by those organisms that lacked the strength or the energy to stem the streams. More marked differentiation and modification are needed to enable an organism to live on the bottom than to exist in fresh water, for the conditions are widely different from those of the surface. Profound darkness prevails; for even the clearest water rapidly extinguishes the sun's rays, and a depth of a few hundred feet will bring eternal night. In the Lake of Geneva, photographic paper exposed at thirty fathoms below the surface was not affected, and Moseley * states that the "Challenger" expedition dredged up blind crustacea from 120 fathoms. Such is not always the case, however; for crustacea with well developed eyes have been found 2,500 feet below the surface, and this seems to point to an illumination of some sort.

In going from the shallow waters found on the continental plateaux to the great depths of thousands of fathoms, it must be remembered, the organisms have not fallen down, but have slowly and deliberately gone to the bottom. It has been a true emigration and has required a steady process of adaptation. The lack of light has made eyes unnecessary, so most deep sea forms are blind. This phenomenon is seen in the fish and crustacea that live in caves, and among them the same device is employed to replace vision as among the denizens of the oceanic depths. The other senses, especially touch, smell and hearing, are developed excessively, even new organs being formed for them. Along the head of the eyeless fish are papillæ consisting of new terminals that constitute an exquisite organ of touch; and the "Challenger" dredged from very deep water an organism, the *Astacus Zalcucus*, closely allied to the common fresh water crayfish, which is eyeless, but has a long, delicate "nipper" that is its means of touch.

But all deep sea organisms are not blind. Some have very large eyes, and, under the law of functional development, these eyes must receive light. Since sunlight is absent, the illumination must come from another source, and this is the phosphorescence of many of the animals themselves. Every one is familiar with the phosphorescence of sea water at night, which is well known to be caused by myriads of minute organisms, but these are by no means the only luminiferous organisms. The profound depths have many inhabitants that shed a "hospitable ray,"

* H. N. Moseley, F. R. S., "Friday Evening Lecture," March 5, 1880, in "Nature," April 8, 1880.

which lightens to some degree the gloom of these realms of darkness.

Vision is not the only function that must be modified to adapt organizations to darkness, for the assimilative apparatus must also undergo change. Since light is essential to vegetation, plant life is absent, and the organisms are entirely carnivorous. No seaweed exists below some thirty-five fathoms, but the surface is rich in organic *débris*. Vast quantities of vegetable matter are washed from the land, and the amount of seaweed growing along the coast is incalculable. Torn from its site, and rent into fragments by storms and cyclones, this mass is gathered into great bodies at some points, as in the Sargasso Sea and furnishes an unfailling food supply to many kinds of organisms. These vegetarians, in turn, become a prey to animals at a lower level, and vegetable food sufficient to supply the demand may thus be handed down through the bodies of successive layers of organisms.

A difficulty that appears to be more serious than any other is the enormous pressure of deep water. This amounts to about a ton to a thousand fathoms for every square inch of surface, but the deep sea organisms become as habituated to it as are the terrestrial ones to the weight of the atmosphere, and their tissues being permeated by water under the same pressure, they are not inconvenienced by it. They are exposed, however, to a danger that is very grave. They may "fall upward" into regions of diminished pressure, where their viscera distend and where they may even burst; a phenomenon similar to that experienced by mountain climbers, but greater in degree. That the normal pressure of the abysmal depths does not prohibit life is shown by the fact that living forms have been dredged from depths of over three statute miles.

The water of the bottom is intensely cold and perfectly still, save in so far as it may be affected by tides; for it is doubtful if currents extend below 100 fathoms. A temperature of 0°C. has been found at 500 fathoms at the Equator, while in deeper water the bottom temperature is two or three degrees lower, being kept from freezing by salt and pressure. In this still, cold water animals acquire the power of appropriating food by mere absorption from the nutrient fluid in which they lie, and the water supplies lime salts to globigerina and crustaceans from which past and future beds of chalk, limestone and marble have been

or are being formed, silicon to diatoms and foods of many kinds to the infinite oceanic fauna.

This abundant supply of food, gathered without effort, leads to indolence; and animals living in the security of the bottom grow more and more inclined to remain stationary. They seek sites to which they may affix themselves, and in time settle down to a vegetative existence, from which neither love nor ambition can tempt them. Enclosed in a protecting shell, encased in a tube or buried in ooze, these organisms have ceased to make the slightest exertion, and, save for a brief period in early youth, are as inert and motionless as a piece of stone. Haeckel has shown that the life of each individual is an epitome of the history of its race, and, viewed in this light, the brief swimming stage of an oyster, for instance, acquires a melancholy interest as a relic of an earlier and higher existence, to which the race clings as a memento of former greatness.

Not content with sheer inaction, some marine animals have sunk to yet a deeper stage of degradation and have become pure parasites, borne about and nourished by more vigorous hosts. Some of these guests select strange places of residence. Crustacea are found in the pharynx of *Salpa* and in the mouths of menhaden; many protozoa live on the mantles of molluscs, and they may be responsible for some of the cases of poisoning that are reported from time to time. The whales and large turtles bear many sucking fish, as well as barnacles; and few of the active animals are free from some such incumbrance. At times, the relation is merely the extension of protection to the smaller. There is a tiny fish that lies between the poison curtains of the *Physalia*, or "Portuguese man-o'-war," from whence it darts forth after its prey, but soon returns to shelter. As the poison of the *Physalia* is extremely irritating, sharks and the like rarely molest it; so these little fish have learned that under its dangerous mantle they can rest in safety.

Life on the bottom exists in its greatest beauty and profusion in water that is free from sediment and shifting sands. On our Atlantic seaboard the conditions are not very favorable, and, though annelids, molluscs and crustaceans abound, the more beautiful forms are scarce. The delicate sea-pen lives on the mud banks, and forms of great symmetry are found; but this is nothing compared with the wealth of a coral lagoon. The vertical

rays of the sun reflected from the bottom make the water as transparent as air; and, as the boat floats slowly across, one can gaze through the glass in the bottom of the boat on a scene of indescribable beauty. Great branching masses of coral of varying hue look like shrubs or even trees. Wonderful anthozoa, or flower animals, and the zoophytes, strange animal-plants, are distributed freely over the bottom. In other places, great lichen-covered rocks seem to be spangled with red, star-shaped flowers: and through and about it all the parrot fish flit, nibbling and browsing on the buds. No garden can equal these oceanic paradises in richness or variety of color; yet they are filled with animals almost to the exclusion of plant life. The lichen is a hydroid coral, the starlike flowers are but the vermilion ends of boring annelids, and the parrot fish do not nibble the stony coral but seek gorgonias, madrepores or small crustaceans. "Strange world in which the animal kingdom blossoms and the vegetable does not."

Such a lagoon would seem an ideal hunting field for pelagic organisms, yet the water yields little to the most persistent hauling. The reason is not far to seek. The sides and bottom are so lined with living animals that they constitute one gigantic mouth into which any unfortunate pelagic organism must fall. On coral reefs the nets will often be well filled on the side against which the surf thunders, and be empty on the lee; for the force of wind and wave is less destructive than the deceitful peace of the calm lagoon.

But marine life is by no means confined to the bottom. From the surface downward the ocean teems with life, to such a degree that naturalists stand aghast as they contemplate its infinite variety. First of all, stand the tiny protozoa, almost microscopic in size, yet on them the bulk of the other organisms subsist. The mass of animal and vegetable life existing in a body of water, and incapable of materially altering position by individual effort, is called the "plankton," and on its amount and character depends the ability of a sea, lake or stream to support life. Fish and other active animals are not included in the plankton, but their ova or larvæ do make part of it. This plankton varies in character in different parts of the sea, and some of its constituents form interesting objects of study. One of them is of great economic importance, as it is the source of marble, chalk and limestone.

This is the globigerina, an animal made famous by Huxley's lecture on "A Piece of Chalk." This tiny creature begins life as a naked bit of protoplasm, but soon covers itself by a coat of lime, through which are fine perforations for threads of protoplasm to extrude. As growth proceeds and the chalk jacket becomes too small, a knob protrudes from the original protoplasm and, in turn, is covered by a layer of chalk. This is repeated until the mature animal seems to be made up of a number of spheres, each opening into a central chamber by a minute aperture. From this opening the group has received the name *foraminifera*. The surface of each sphere is pierced by fine holes, and through each hole a thread of protoplasm extends into the water for nourishment. After death, these sink to the bottom and make the "globigerina ooze," the future limestone and marble beds. The greater part of the bed of the Atlantic is composed of this ooze, and yet infinite numbers fall victims to the needs of more powerful neighbors.

The foraminifera are not the only organisms in which the sea is prolific, for the numbers of some of its groups surpass the most extravagant calculations. The British exploring steamer "Challenger" once steamed for two days through one species of Copepod; and the number of tiny creatures necessary to produce the phosphorescence of sea water may be imagined more readily than estimated. Other varieties are at times so abundant as to color the water for miles, a phenomenon that has produced many superstitions among sailors.

The scope of this paper will not permit an extended notice of individuals or even of families of marine organisms. The results of the past thirty years have shown the wealth of material yet to be investigated. The sea is an inexhaustible object of study, whether from a geographical, physical, geological or biological point of view. As yet only a few glimpses are available, because of the practical difficulties that block the way. Suppose some explorer from another planet, to whose vision our atmosphere was impenetrable, should float his air-ship some four or five miles from the earth's surface, and drop a hollow rod or a small net through the darkness. The chances are that he would fail to capture a single bird or animal; snakes, butterflies and almost every familiar animal would elude so obvious a danger, and the traveller would return to report the earth a desert. Yet, this is

practically what is done in deep-sea sounding and dredging, and on such data conclusions must be based. From time to time, some forcible reminder of the incompleteness of our knowledge comes to light. In the stomach of a red snapper a fish was found belonging to an otherwise unknown species and one that probably would have remained undiscovered for years but for a lucky accident. The fate of the shad after it returns to the sea is a mystery. Another example is the common fresh water eel, whose mode of reproduction has been a matter for speculation since the days of Aristotle. An old idea in regard to it was that the young eels sprang from mud. Later, it was thought that eels are hermaphrodite; but Dr. Theodore Gill of Washington and an Italian named Gassi have at last solved the problem. The eel that frequents the rivers is the female; and at the breeding time she descends to the sea to meet the male. When her destination is reached the dark dress is doffed and one of silver gray assumed. She then seeks a depth of some three thousand feet, where her mate awaits her. His coat is always silvery and his eyes are much larger than those of the female, so that few would suspect him of being allied to our common eel. The young were not recognized as such but were classed as a family of fish under the generic name of *Leptocephalus*, the *L. brevirostris* being the young of the common eel. Dr. Gill first showed the truth in the case of the conger eel, but this illustration, taken from so familiar an animal, shows how much still remains to be discovered.

In every civilized country numerous workers are eagerly studying the natural history of the sea. Something has been done; but more remains to be accomplished before we shall have solved the mysteries of the deep.

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